DOCUMENT RESUME

ED 264 106 SE 046 266

TITLE	Trap the Energy of the Sun. What We Make. Science and Technology Education in Philippine Society.
INSTITUTION	Philippines Univ., Quezon City. Inst. for Science and Mathematics Education Development.
SPONS AGENCY	National Science and Technology Authority (Philippines).
PUB DATE	Jan 84
NOTE	31p.; For other documents in this series see SE 046 255-274.
AVAILABLE FROM	University of the Philippines, Institute for Science and Mathematics Education Development, Pardo de Tavera St., Diliman, Quezon City, Philippines ($1.70).
PUB TYPE	Guides - Classroom Use - Materials (For Learner) (051)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Alternative Energy Sources; *Energy Education; Food; Foreign Countries; High Schools; Learning Activities; *Science Activities; Science Education; *Secondary School Science; *Solar Energy
IDENTIFIERS	*Philippines; *Solar Food Dryers

ABSTRACT

Filipino scientists and inventors have tried many ways of using solar energy. One simple device, made of wood and ordinary plastic sheets, traps solar energy to dry palay grains and other agricultural products. In this module, information and activities are provided to help students: (1) learn the advantages of using a solar crop dryer over direct sun drying; (2) build a low-cost solar crop dryer; (3) compare the drying time in the dryer and in direct sun drying using palay grains; (4) measure and compare the temperature of the air inside and outside a dryer; (5) make design changes in the dryer and observe the effect on dryer time; and (6) build a dryer three times as large as the first one. Each activity includes a list of materials needed and detailed procedures. A short mastery test (with answers) is provided. (JN)

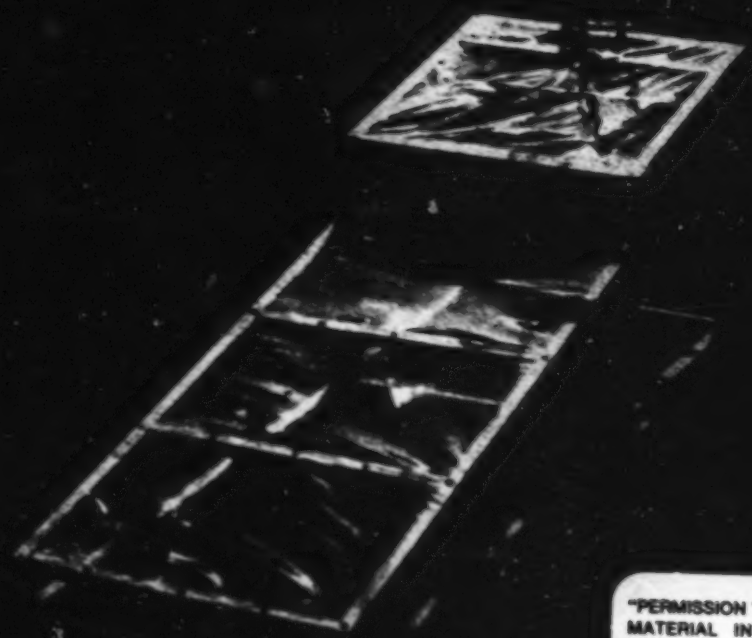
****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.



SE 046 266

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Univ. of the Philippines
Inst. for Science and Math.
Education Development

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

5

Trap the Energy of the Sun

This is one of a series of science modules prepared by the University of the Philippines Science Education Center (UPSEC) funded by the National Science and Technology Authority (NSTA).

Section 9, P.D. 49: "No copy shall subsist in any work of the government of the Philippines. However, prior approval of the government agency or office wherein the work is created shall be necessary for exploitation of such work for profit. Such agency or office may, among other things, impose a condition the payment of royalties."

Published and printed by the

SCIENCE EDUCATION CENTER
Vidal A. Tan Hall
University of the Philippines
Diliman, Quezon City

January, 1984

TRAP THE ENERGY OF THE SUN

PROJECT TEAM

Project Leader Vivien M. Talisayon

Writer Rosea L. Aguilar

Reviewers Dolores F. Hernandez
Porfirio P. Jesuitas
Reinders Duit

Illustrators Gladys L. Balacuit
Rogelio C. Acacio

Typists Dorcas Y. Rocabo
Zenaida N. Bose

Compositor Delfin Y. Sanchez

Layout Artist Victor R. Isunza

Publication Staff Cesar M. Sagun
Regino L. Lamorena
Ruben L. Gabuat
Guillerma F. Plata
Arturo V. Abaloyan
Renante M. Lunas
Erlando B. Mangasar
Pedro A. Laurino

ACKNOWLEDGMENT

Grateful acknowledgment is due the following for their assistance in the development of the lesson.

For the design of the dryer: *Dr. Emerico R. Mendoza* and *Mr. Conrado Baltazar,* Department of Agricultural Engineering and Technology, U.P. at Los Baños

For the tryout of the lesson: *Pres. Miguel Palao,* Palawan National Agricultural College, Aborlan, Palawan

Third and Fourth Year Students (1979-1980), Antipuluan MAR-PNAC Bayanihan Center, Antipuluan, Palawan

Trap the Energy of the Sun

Have you seen palay being dried on the road during a sunny day?

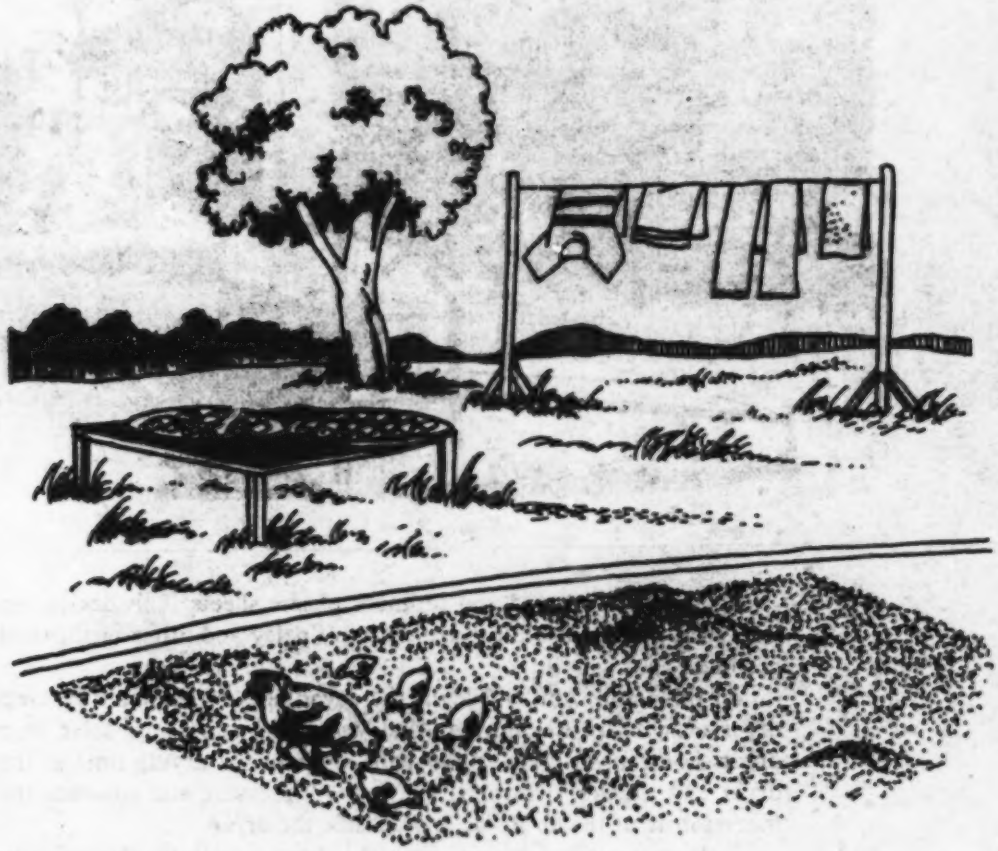


Figure 1

The grains are exposed to dirt and animals. Stones can mix with the grains. For uniform drying, the grains have to be turned over every now and then. If rain comes suddenly, the grains have to be gathered fast. Is there a better way of drying palay under the sun?

Filipino scientists and inventors have tried many ways of using the energy of the sun or solar energy. One simple device (Fig. 2) called a solar crop dryer was constructed at the University of the Philippines at Los Baños (UPLB).

Figure 2

It is made of wood and ordinary plastic sheets. This device can trap solar energy and can be used to dry palay and other agricultural products.

In this lesson you will learn the advantages of using a solar crop dryer over direct sun drying. You will build a low-cost solar crop dryer. Using palay grains, you will compare the drying time in the dryer and in direct sun drying. You will measure and compare the temperature of the air inside and outside the dryer.

This lesson also explains how the dryer functions. One activity in this lesson allows you to make design changes in the dryer and observe the effect on drying time. Another activity enables you to build a dryer three times as big as the first one.

Research on solar devices is changing fast. The solar crop dryer you will build may be replaced by better models. What is important is to learn how the dryer functions and the skills needed in designing it. You may be able to design a better model yourself.

Build A Solar Dryer

The solar dryer (Fig. 2) which you will make has three parts: the heat collection chamber, drying box, and chimney. In Activity 1 you will construct a dryer that can hold about 4 gantas (about 6 kg) of palay at a time.

Activity 1

Construction of the solar dryer takes about 5 hours. You may construct it at home or in school during your free time.

You need:

5 blocks of wood, each 1.25 cm X 2.5 cm X 2.5 m*
(or whole bamboo with diameter 6-8 cm and 2 m long)
block of wood, 1.25 cm X 2.5 cm X 2 m**
(or whole bamboo with diameter 6-8 cm and 65 cm long)
block of wood, 1.25 cm X 7.5 cm X 2 m***
(or scraps of plywood, 40 cm X 6.4 cm)
0.1 kg No. 1 nails
wire screen or mesh or plastic screen, 45 cm X 45 cm
(or bamboo matting consisting of about 20 pieces of 40 cm X 1 cm sticks)
transparent plastic sheet, gauge 3 or 4, 3.6 cm
2 boxes thumbtacks
small ball of thin abaca string (if using bamboo)
small can of black paint (if desired)

You can buy the wooden blocks from a lumberyard, the nails and screen from a hardware store, and the plastic and thumbtacks from a bookstore or school supply store. For the substitute materials, look for scraps of plywood in your home. Bamboo can be bought in the market.

A. For the heat collection chamber, with a saw cut the 1.25 cm X 2.5 cm X 2.5 m blocks of wood into:
2 pcs., each about 38 cm X 2 cm X 1 cm
2 pcs., each about 25 cm X 2 cm X 1 cm
9 pcs., each about 41 cm X 2 cm X 1 cm
2 pcs., each about 52 cm X 2 cm X 1 cm
2 pcs., each about 136 cm X 2 cm X 1 cm

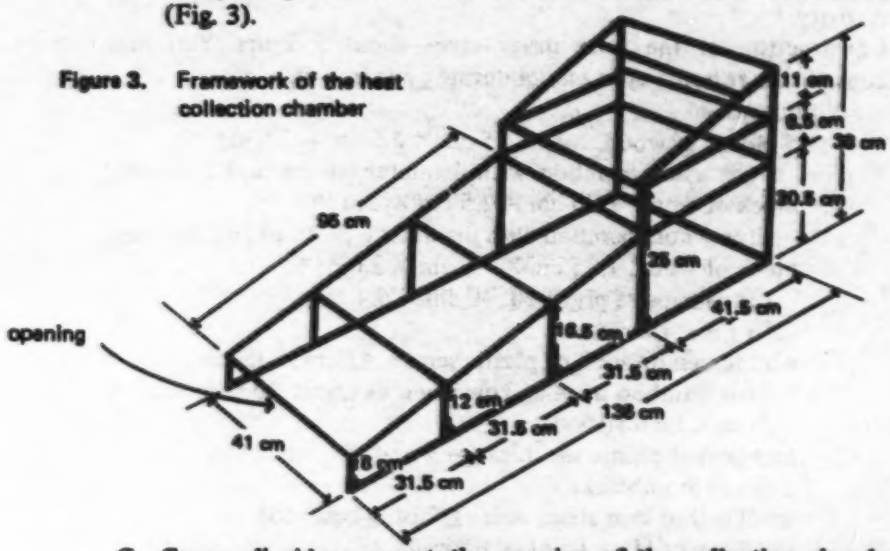
* about 1/2 inch X 1 inch X 8 ft
** about 1/2 inch X 1 inch X 6 ft
*** about 1/2 inch X 3 inches X 6 ft

2 pcs., each about 95 cm X 2 cm X 1 cm
2 pcs., each about 12 cm X 2 cm X 1 cm
2 pcs., each about 16.5 cm X 2 cm X 1 cm
2 pcs., each about 8 cm X 2 cm X 1 cm

If using bamboo, make the length 2 cm longer on both ends to allow joining.

B. Using the pieces of wood, construct the heat collection chamber (Fig. 3).

Figure 3. Framework of the heat collection chamber



C. Cover all sides, except the opening of the collection chamber with plastic. Use thumbtacks to put the plastic in place.

D. Cut the 1.25 cm X 7.5 cm X 2 m block of wood into four equal lengths each about 40 cm.

E. Construct the drying box (Fig. 4) using the pieces of wood in D and wire screen or mesh. Nail a 6 cm X 2 cm X 1 cm piece of wood to one side of the box to serve as handle.

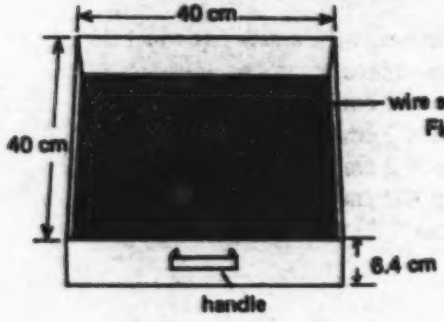


Figure 4. The bottom of the drying box is made of wire screen or mesh.

If plastic screen is used in the drying box instead of wire mesh, place pieces of bamboo support under the screen (Fig. 5).

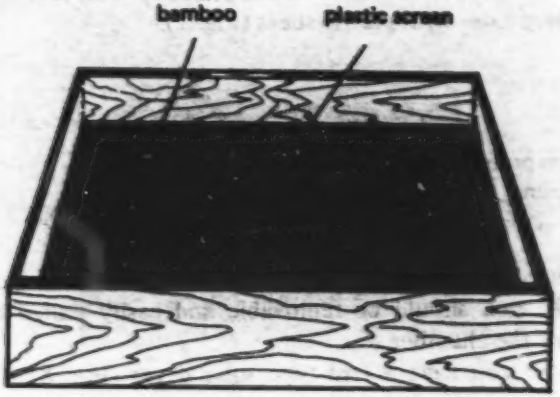


Figure 5

If using bamboo matting, place a thin piece of cloth or sack on it to hold the palay.

F. Cut the 1.25 cm X 2.5 cm X 2 m block of wood into:
   3 pcs., each 61 cm X 1 cm X 1 cm
   12 pcs., each 12 cm X 1 cm X 1 cm
   6 pcs., each 16 cm X 1 cm X 1 cm

G. Construct the chimney using the pieces of wood (Fig. 6). Cover the sides of the chimney with plastic, leaving both ends open. Use thumbtacks to put the plastic in place.

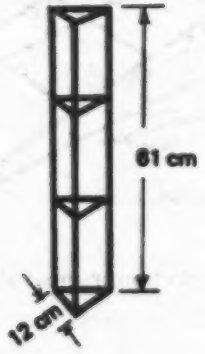


Figure 6

If bamboo is used, the pieces can be joined together using 20-cm string.

H. Nail the chimney to the collection chamber as in figure 8.

I. Make the hat of the chimney using the 6 blocks of wood, each 16 cm X 2 cm X 1 cm and cover the chimney with it (Fig. 8). Cover the three sides with plastic sheet (Fig. 7).

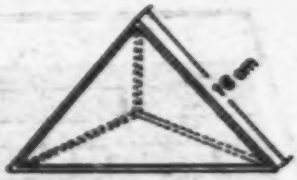


Figure 7. The hat protects the grains from rain.

J. Put the drying box into its place in the collection chamber (Fig. 8). The box should be removable and easily pulled out at the back of the chamber.

Now you have a tent-type solar dryer (Fig. 8). This device can be used to collect solar energy to dry agricultural crops like palay, corn and peanuts. It can also be used to dry fish.

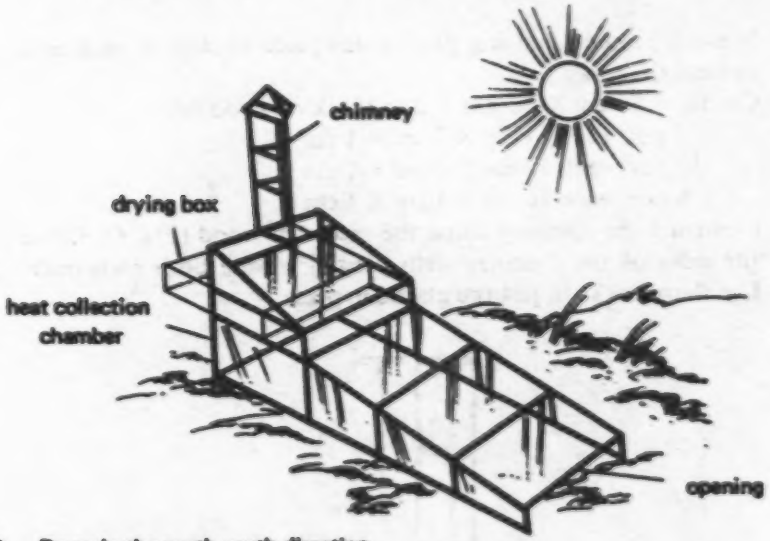


Figure 8. Dryer in the north-south direction. The sun rises on the east.

To make the dryer absorb more heat all parts except the plastic can be painted black.

Drying Palay In A Solar Dryer

What advantages does the solar dryer have over direct sun drying? Find out in the following activity. The best time to do this activity is on a sunny day, between 11:00 a.m. and 2:00 p.m., when the heat from the sun is great.

Activity 2

You and a partner need:

- constructed solar dryer
- 4 gantas of palay grains (about 6 kg)
- 3 thermometers
- big can of gravel
- ruler
- sack or thick cloth or newspaper
- wooden box with bottom made of wire mesh and the same dimensions as the drying box of the solar dryer with four legs, each leg about 20.5 cm tall
- 2 small, empty milk cans, open at one end

A. Fill one milk can with palay grains. Bring this to a nearby National Grains Authority (NGA)* office. Have the moisture content of the grains measured with a moisture meter (Fig. 9).

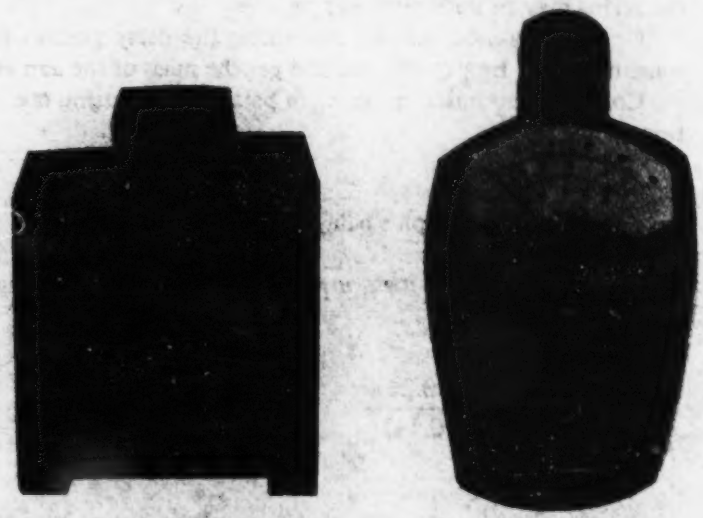


Figure 9. (a) Dole moisture meter, (b) Gann Hydromette (Courtesy of National Grains Authority, Quezon City)

*Now called National Food Authority.

Moisture meters are also available at the Land Bank of the Philippines (LBP) office. Arrange a field trip to an NGA or LBP office. Request a demonstration on the use of a moisture meter.

The purpose of drying crops after harvest is to reduce their moisture content. The moisture content is the amount of water contained in the crop. For example, the moisture content of palay grains right after harvest is about 26% of its mass. When palay is sufficiently dry, its moisture content is about 14% of its mass. When this is reached, palay is safe for storage.

If moisture content is higher than 14%, fungi may grow in the grains. This may result in discoloration, bad smell, reduced ability to germinate, loss of weight, and in the production of poisonous substances. If grains are milled before they are sufficiently dry, they become powdery.

Many farmers say that palay is sufficiently dry if crispy when bitten. An accurate way to tell whether palay is sufficiently dry is to get its moisture content using moisture meters (Fig. 9).

Many farmers sell some of their harvest to NGA. One basis of pricing palay is its moisture content. Palay with moisture content safe for storage gets a better price. So, knowing the exact moisture content of palay is important.

If moisture meter is not available, the moisture content of the grains may be determined as follows:

Get the mass of the can containing the palay grains using a weighing scale. Empty the can and get the mass of the can alone.

Compute the initial mass m_i of palay sample, using the equation,

$$m_i = \text{mass of can plus palay} - \text{mass of empty can}$$

Compute the final mass m_f of your palay sample using the equation,

$$m_f = \frac{m_i(1-0.26)}{(1-0.14)}$$

You know that 0.26 and 0.14 are the decimal equivalents of 26% and 14% respectively. The equation is based on initial mois-

ture content of 26% and final moisture content of 14%. The equation makes use of the fact that the mass of the palay grains without moisture is constant.

For example, if $m_i = 50$ g, then

$$m_f = \frac{(50\text{ g})(1-0.26)}{(1-0.14)} = 43\text{ g}.$$

With an initial mass of 50 g and a final mass of 43 g, the final moisture content is 14%.

B. Take the solar dryer outside, away from tall trees and houses. Let its opening face the south (Fig. 8).

As shown in Fig. 8, the top surface of the dryer is tilted to the south for the dryer to receive the most sunlight. From sunrise to sunset, the path of the sun to an observer in the Philippines appears for most of the year tilted to the south.

C. Cover the ground under the dryer with gravel. If the activity is done over a cemented area, gravel need not be used.

D. Pull out the drying box from the dryer. Place 2 gantas (about 3 kg) of palay grains in the box and level off the grains with your hand. Return the box to its place in the dryer.

E. Place the other 2 gantas of palay in the wooden box you prepared. Call this the control box. Again, level off the grains with your hand. Let the control box stand beside the solar dryer (Fig. 10).

F. Place a thermometer at the center of the drying box with the bulb buried in the grains. Similarly, place a thermometer in the control box (Fig. 10).

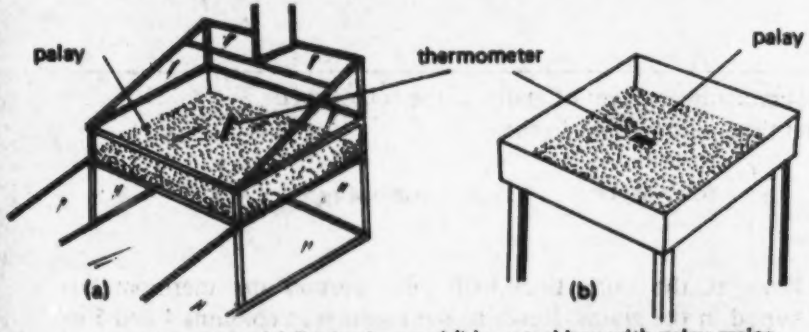


Figure 10. (a) Drying box and (b) control box with palay grains

During sunny days, it takes about 2 hours to sufficiently dry 2 gantas of palay using the solar dryer with initial moisture content of about 18% - 20%.

☐ 1. a. Make a table like Table 1 on your notebook.
b. Write the date you perform the activity and record the original moisture content of your palay.

Table 1. Data for Activity 2

Date:
Original Moisture Content:

No. of days	Reading no.	No. of min.	Temperature of grains in the drying box (°C)	Temperature of grains in the control box (°C)	Weather condition (windy, cloudy, sunny)
(1)	(2)	(3)	(4)	(5)	(6)
day 1	1	0			
	2	5			
	3	30			
	4	30			
	,	,			
	,	,			
	,	,			
day 2					

Final moisture content of grains in the solar dryer:
Total time to dry grains in the:

solar dryer: control box:

G. Read at the same time with your partner the thermometers buried in the grains. Record your readings in columns 4 and 5 of Table 1. Record, too, the weather condition in column 6.

H. About 5 minutes after the first readings, observe the plastic cover above the drying box.

☐ 2. a. Where do the water droplets on the plastic sheet come from?

I. Repeat G 30 minutes after the first reading.

J. Observe again the plastic sheet above the drying box.

☐ 3. What happens to the water droplets on the plastic sheet?

K. Repeat G 30 minutes after the second reading. Examine the top and bottom grains in the two boxes.

☐ 4. a. Are the grains in the drying box uniformly dried?

b. How about the grains in the control box?

L. Repeat G every 30 minutes until the grains look sufficiently dry. If the temperature in the drying box is greater than 43.3°C, cover the heat collection chamber with sack or newspapers to reduce the heat trapped. Palay is known to crack at temperatures above 43.3°C. When this happens, the grains will be destroyed and cannot be used for planting again.

M. Bite a grain from each box. Repeat A for the crispy grains and do P.

N. Continue drying the grains that are not crispy. Repeat L.

O. Bite a grain. If crispy, repeat A.

P. If the moisture content of the grains is about 14%, store the grains. If greater than 14%, continue the drying. Repeat L and O.

If no moisture meters are available for steps M to P, get the final mass of the palay sample using the weighing scale (see description following step A). When the measured mass is equal to the computed final mass, the final moisture content of your sample is 14%.

☐ 5. Record in your Table 1 the final moisture content of grains in the two boxes.

☐ 6. From column 3 of your Table 1, compute the total time for drying the grains in the solar dryer and for direct sun drying. Record the data in your table.

☐ 7. Look at columns 4 and 5 of your table. Where is temperature higher, in the drying box or control box?

☐ 8. a. With what palay sample do you obtain the desired final moisture content first?

b. Does your answer support your answer in ☐6?

☐ 9. a. Which dries palay grains faster, using the solar dryer or drying your palay directly under the sun?

b. Explain your answer.

☐ 10. What is one advantage of using the solar dryer to dry palay over direct sun drying?

☐ 11. Considering dust, rain, and wind, what are other advantages of using the solar dryer over direct sun drying?

Other crops like corn and peanuts can be dried in the solar dryer. The moisture content safe for storage is also 14% for corn, 10% for peanuts and 12% for beans. The maximum temperature to which corn can be exposed without cracking is about 60°C. For shelled peanut, it is about 37.8°C.

The Drying Process

High-energy radiation from the sun passes through the plastic cover. The air, wood, gravel, and other materials inside the dryer absorb this radiation and in turn radiate low-energy radiation. Low-energy radiation or heat cannot pass through a transparent material like plastic or glass. So, heat is trapped in the dryer (Fig. 11) and the air inside is kept warm.

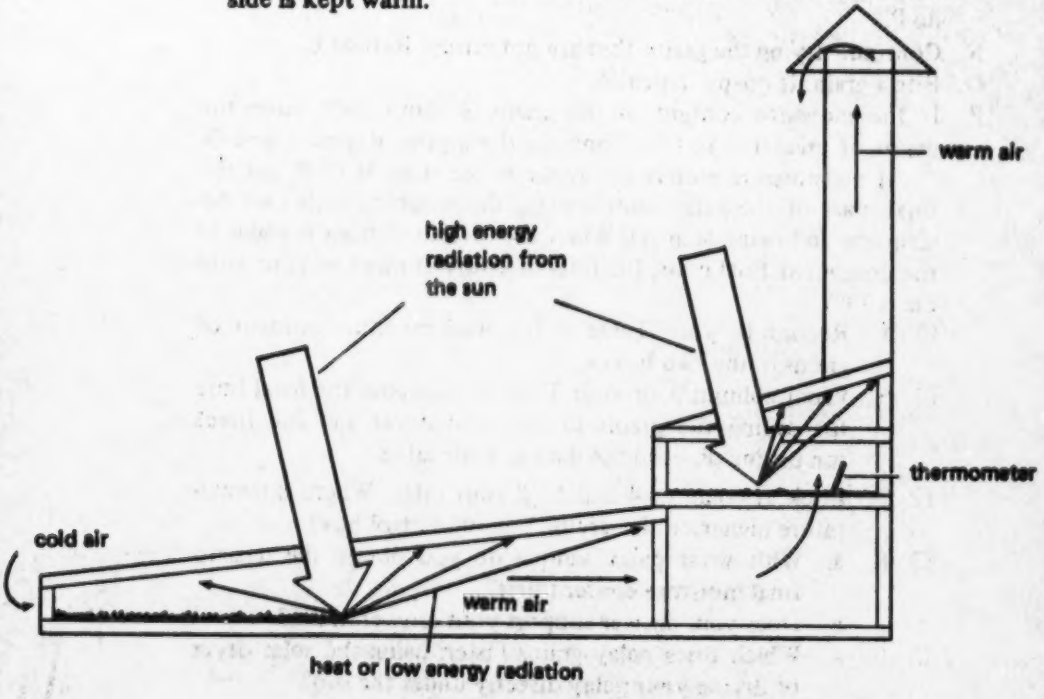


Figure 11. Heat trapped and air flow in a dryer

☐ 12. Explain your answer in ☐7 based on the heat trapped in the dryer.

So, cold air entering the heat collection chamber (Fig. 11) becomes warm. The warm air rises and goes through the grains and out of the chimney.

More cold air is drawn into the collection chamber to replace the rising warm air. This movement of air due to temperature difference is called convection. The design of the dryer allows for continuous convection.

☐ 13. Explain your answers in ☐4 in terms of convection.

So, the grains are dried by the warm air above the drying box and by the rising warm air coming from below the box.

☐ 14. Based on the drying process, explain your answer in ☐9a.

What happens to the moisture of the grains in the drying process?

As the water particles in the grains absorb heat from the warm air inside the dryer, the energy of the particles increases. They move faster and farther apart. The water evaporates or slowly changes into gas called water vapor. The water vapor leaves the grains and goes into the surrounding air.

Recall the water droplets that you observed on the plastic sheet. At the start of the drying process, the air containing the water vapor is warmer than the plastic sheet. Recall how heat is trapped inside the dryer. The cooler plastic sheet absorbs heat from the air and water vapor. As a result, some water vapor condenses or changes back to liquid.

As the drying process continues, more sunlight goes through the plastic sheet. The water droplets absorb heat and change again into water vapor. Some of it is carried away by the rising warm air out of the chimney.

Designing a Solar Dryer

In the development of the solar dryer, the dimensions which may affect its drying time are considered. For example, the chimney was made to guide the water vapor to escape. Would a longer chimney make water vapor escape faster? Do the next activity to find out how changes are made in designing a solar dryer.

Activity 3

You and a partner need:

- solar dryer constructed in Activity 1
- 3 blocks of wood, each 1.25 cm X 1.25 cm X 92 cm*
- 3 blocks of wood, each 1.25 cm X 2.5 cm X 31 cm**
- transparent plastic, 96 cm X 40 cm
- transparent plastic, 35 cm X 40 cm
- 60 No. 1 nails
- 50 thumbtacks
- 3 thermometers
- paper, 50 cm X 10 cm
- newspaper or sacks

This activity takes about 7 to 8 hours and may be done on a Saturday. If done during the regular one hour class days, the activity can be spread out over several days.

On the fourth to seventh day, D can be done 5 to 10 minutes after C.

A. Construct a longer chimney with dimensions shown in Fig. 12. Cover the three sides with plastic as in Activity 1.

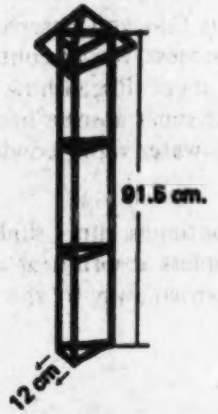


Figure 12. Chimney one-half taller than the standard

*about 1/2 inch X 1/2 inch X 3 ft
**about 1/2 inch X 1 inch X 1 ft

B. Repeat A, but construct a chimney with dimensions shown in Fig. 13.

Figure 13. Chimney one-half shorter than the standard

☐ 15. Make a table like Table 2 on your notebook.

Table 2. Data for Activity 3

Change in the dryer (1)	Temperature in the drying box (°C) (2)	Temperature in the control box (°C) (3)	Difference in temperature (°C) (4)
none			
opening closed			
top and sides of drying box are covered			
chimney 2 times higher			
chimney 1/2 taller			

C. Take the standard solar dryer and control box outside, under the sun, as in Fig. 8. As before, let the opening of the dryer face south.

D. After 30 minutes, work with your partner in taking the temperature of the air in the drying box and control box at the same time.

☐ 16. a. Record your readings in row 1, columns 2 and 3 of your Table 2.

b. Compute the difference in temperature and fill in column 4 of your Table 2.

E. Using paper and thumbtacks, cover the opening of the dryer.

☐ 17. What happens to the supply of cold air when the opening of the solar dryer is covered?

F. Repeat D after one hour.

☐ 18. a. Record your readings in your Table 2.

b. Compute the difference in temperature and compare it with the temperature difference in ☐16.

c. Does the difference in temperature increase or decrease?

☐ 19. Based on your answer in ☐17,

a. does covering the opening of the dryer increase or decrease convection?

b. What happens to drying time?

G. Remove the paper covering the opening. Cover the top and sides of the drying box with sacks or newspaper (Fig. 14).

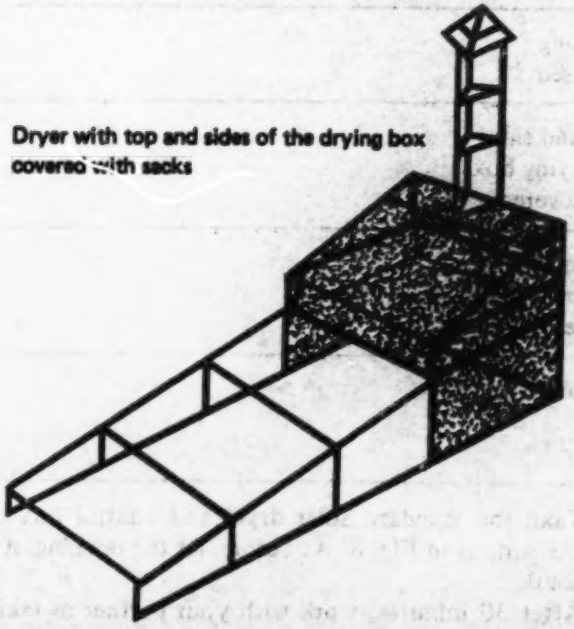


Figure 14. Dryer with top and sides of the drying box covered with sacks

☐ 20. With the drying box covered, does the air inside absorb more, less, or the same amount of sun's radiation?

H. After one hour, repeat D.

☐ 21. Answer ☐18 again.

☐ 22. Based on your answer in ☐20, how does covering the top and sides of the dryer affect drying time?

I. Remove the covering of the drying box. Replace the chimney of the standard solar dryer with the longer chimney you constructed.

J. After one hour, repeat D.

☐ 23. Answer ☐18 again.

☐ 24. Is drying time longer or shorter when the chimney is higher than the standard?

K. Repeat I and J using the shorter chimney.

☐ 25. Answer ☐18 again.

☐ 26. Is drying time longer or shorter when the chimney is shorter than the standard?

You have observed that the height of the chimney, supply of air and direct sunlight affect the drying time in the dryer.

Engineers at UPLB claim that the dimensions of the dryer you constructed in Activity 1 give the best results. However, your dryer can dry only a limited amount of palay (about 4 gantas) at a time. To dry about 4 cavans of palay at a time, use a dryer that is three times as big. Do the next activity.

Activity 4

A. To have a list of needed materials, compute the dimensions of a dryer 3 times as big as what you have. For example:

$$\text{height of chimney} = \text{original height} \times 3$$
$$= 60\text{ cm} \times 3 = 180\text{ cm}$$

So, if the height of your chimney now is 60 cm, the height of the bigger chimney must be 180 cm or 1.8 m.

☐ 27. Record in your notebook your computations for the dimensions of the dryer 3 times as big as what you have.

□ 28. Copy figure 15 and put in your dimensions.

Figure 15.

B. See page 24 to find out if your dimensions are correct.

C. Construct the dryer in figure 15 using the new dimensions. It can dry 4 cavans of palay at a time.

□ 29. Summarize what you have learned from this lesson by:

a) giving the advantages of the solar dryer over direct sun drying.

b) explaining the two ways by which grains are dried in the solar dryer.

c) explaining how length of chimney, covering the opening, and covering the drying box affect drying time in the solar dryer.

*Compare your answers to the questions marked □ in the lesson with the key on pages 20-24 before taking the Mastery Test.

Mastery Test

*Choose the BEST answer. On a separate sheet, write only the letter corresponding to your answer.

1. Which statement about the solar dryer is false?
   a. It dries agricultural crops faster than direct sun drying.
   b. It protects the crops from rain and dust.
   c. It keeps the crops away from animals.
   d. Temperature inside is easily decreased by wind.
   e. Temperature inside is higher than the surrounding temperature.

2. Changes in the design of a solar crop dryer should result in
   a. increased convection inside the dryer.
   b. less heat trapped inside the dryer.
   c. greater heat lost to the surroundings.
   d. lower temperature inside the dryer.
   e. less evaporation of moisture from the crop.

For questions 3 and 4:
Three solar dryers of the same dimensions are each used to dry 3 gantas of palay at the same time. After 3 hours, the values of their moisture content are shown in Table 3.

Table 3

Palay	Moisture Content
A	14.3%
B	16.8%
C	18.5%

3. Which palay sample is safe for storage after 3 hours of drying?
   a. A only
   b. B only
   c. C only
   d. A and B only
   e. B and C only

4. Which sample had the highest original moisture content?
   a. A only
   b. B only
   c. C only
   d. A and B only
   e. B and C only

For questions 5 and 6:
The drying box of a solar dryer has the dimensions, 65 cm X 60 cm X 12 cm.

5. What would be the dimensions of the box if the dryer is made twice as big?
   a. 65 cm X 120 cm X 12 cm
   b. 130 cm X 60 cm X 12 cm
   c. 65 cm X 60 cm X 24 cm
   d. 130 cm X 120 cm X 24 cm
   e. 130 cm X 30 cm X 6 cm

6. The capacity of the box to hold grains would be
   a. increased 2 times.
   b. decreased 2 times.
   c. increased 4 times.
   d. decreased 4 times.
   e. increased 8 times.

*Compare your answers with the key on page 25.

Key to Questions Marked □ in the Text

□ 1.

Table A. Sample Data for Activity 1

Date: October 25, 1979
Original moisture content: 18.8%

No. of days (1)	Reading no. (2)	No. of min. (3)	Temperature of grains in the drying box °C (4)	Temperature of grains in the control box °C (5)	Weather condition (windy, cloudy or sunny) (6)
day 1	1	0	28	28	sunny
	2	5	30	28	sunny
	3	30	32	30	sunny
	4	30	39	32	sunny & windy
	5	30	44*	34	sunny
	6	30	42	36	sunny
	7	30		38	sunny
	8	30		39	sunny

*Palay may crack or get burned at this temperature. Chamber was covered with paper and cartolina at this time; hence the decrease in temperature after 30 minutes.

Final moisture content of grains in the solar dryer: 14.5%
Total time to dry grains in the
Solar dryer: 2 hours and 5 minutes
Control box: 3 hours and 5 minutes

☐ 2. From the grains

☐ 3. They disappeared.

☐ 4. a. Yes.
b. The grains in the control box are not uniformly dried. (The grains at the bottom are less dry than those on top).

☐ 5. (See sample data in Table A.)

☐ 6. (See sample data in Table A.)

☐ 7. In the drying box

☐ 8. a. The palay sample in the drying box.
b. Yes. (The total time to dry grains was less in the solar dryer than in the control box.)

☐ 9. a. Using the dryer
b. Total drying time is less using the solar dryer than direct sun drying.

☐10. Less drying time

☐11. With the solar dryer, palay is protected from dust, rain, and wind. (The palay is also protected from stray animals and birds. In direct sun drying, the grains may be exposed to intense heat and moisture in the air. As a result, the grains harden, crack easily, and do not dry uniformly.)

☐12. Temperature is higher in the drying box because of the heat trapped inside the dryer. (Low-energy radiation or heat cannot pass through the plastic cover.)

☐13. Unlike in the control box, there is continuous convection in the drying box. The grains at the bottom of the drying box are dried by the warm rising air coming from below.

☐14. The solar dryer dries palay grains faster because of the warmer air above the drying box and the rising warm air coming from below.

□15.

Table B. Sample Data for Activity 3

Change in the dryer (1)	Temperature in the drying box (°C) (2)	Temperature in the control box (°C) (3)	Difference in temperature (°C) (4)
none	37	28	9
opening closed	37	32	5
top and sides of drying box are covered	39	34	5
chimney 1/2 taller	40	45	5
chimney 1/2 shorter	42	36	6

□16. a. (See sample data in Table B.)
b. (Based on the sample data, the difference in temperature is 9°C.)

□17. The supply of cold air in the collection chamber stops.

□18. a and b. (See sample data in Table B.)
c. The temperature difference decreased. It is lower than that of □16.

□19. a. Convection decreases and later on stops when supply of cold air in the chamber is stopped.
b. Drying time is longer.

□20. less radiation

□21. a and b. (See sample data in Table B.)
c. (Based on sample data, the difference in temperature decreased. It is 5°C, lower than that of □16.)

□22. Drying time is longer.

□23. a and b. (See sample data in Table B.)
c. The difference in temperature decreased. It is 5°C, lower than that of □16.)

□24. Drying time is longer. (Temperature difference is smaller than when regular chimney is used. With higher chimney it takes longer for warm air to go out of the dryer. This means longer time for fresh warm air to pass the grains.)

□25. a and b. (See sample data in Table B.)
c. (Based on sample data the difference in temperature decreased. It is lower than that of □16.

□26. Drying time is longer. (Temperature difference is smaller than when regular chimney is used. With a shorter chimney, warm air passes the grains fast. Not enough heat is absorbed by the grains.)

□27. Computations for the dimensions of a dryer 3 times as big as what you have:

chimney

height = 61 cm X 3 = 183 cm
length of side of triangular base =
12 cm X 3 = 36 cm
length of side of hat =
16 cm X 3 = 48 cm

wire screen

length = 42 cm X 3 = 126 cm
width = 38 cm X 3 = 114 cm

drying box

length = 40 cm X 3 = 120 cm
width = 34 cm X 3 = 102 cm
height = 6.5 cm X 3 = 19.5 cm

collection chamber

lower length = 136 cm X 3 = 408 cm
upper length = 95 cm X 3 = 285 cm
width = 41 cm X 3 = 123 cm
$height_1$ = 8 cm X 3 = 24 cm
$height_2$ = 12 cm X 3 = 36 cm
$height_3$ = 16.5 cm X 3 = 49.5 cm
$height_4$ = 25 cm X 3 = 75 cm
$height_5$ = 38 cm X 3 = 114 cm

□28.

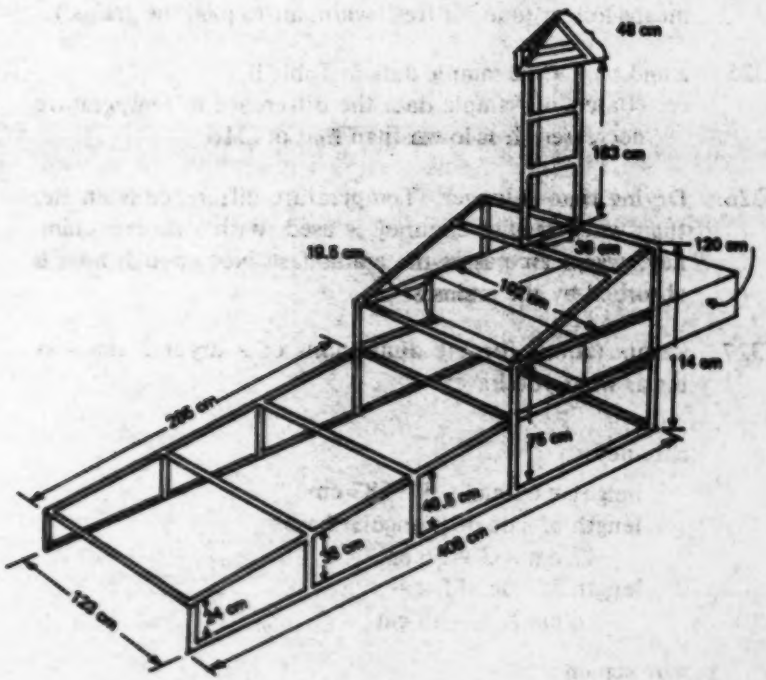


Figure 16

□29. a. Temperature inside the solar dryer is higher than that outside. So, drying time is shorter. The dryer protects the grains from wind, dust, rain, stray animals and birds. In the dryer, conditions like heat and moisture in the air can be controlled, improving the quality of the grains.

b. Grains are dried in the solar dryer by heat trapped inside and by continuous convection.

c. Making the chimney longer or shorter, covering the opening or the drying box increase drying time.

Key to Mastery Test

1. d.
2. a.
3. a. (Palay is safe for storage if its moisture content is about 14%.)
4. c. (For the same drying time, the sample with the highest final moisture content had the highest initial moisture content.)
5. d. (The length, width and depth of the box each will increase 2 times.)
6. e. (The volume of the box was increased 8 times: 2 X 2 X 2. So its capacity to hold grains is increased 8 times.)

References:

1. Australian Science Education Project. *Solar Energy.* Teacher Edition. State of Victoria, Australia, 1974, p. 26.
2. Center for Nonconventional Energy Development. *Mobile Solar Dryer.* Pamphlet Series on Appropriate Energy Technologies. Ministry of Energy, Fort Bonifacio, Metro Manila, Sept. 11, 1979.
3. Christensen, Clyde M. and Kaufmann, Henry H. *Grain Storage.* Minneapolis: University of Minnesota Press, 1969. pp. 4-10, 108-114.
4. Mendoza, Emerico R. *Build A Solar Dryer.* Brochure INSAET, UP at Los Baños, 1979.
5. U.P. Science Education Center. *High School Science I: Exploring Our Environment.* Philippines: EDPITAF, 1977, pp. 182-184, 194-196, 208-212.